STATE OF CALIFORNIA
The Resources Agency
Department of Water Resources
Northern District

DORRIS-BUTTE VALLEY
WATER QUALITY INVESTIGATION

Office Report

MARCH 1968

RONALD REAGAN
Governor
State of California

WILLIAM R. GIANELLI
Director
Department of Water Resources

FOREWORD

In 1964, small amounts of arsenic were detected in various wells in Butte Valley, Siskiyou County. Four wells, utilized by the City of Dorris for their water supply, showed a definite increasing trend in the amount of arsenic from 1964 to 1966. In May 1966, the Water Quality Unit of the Northern District initiated an investigation to define the area of impaired water, locate possible sources of impairment, and formulate recommendations which could lead to the solution of this water quality problem. This report gives the results of that investigation.

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State of California
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FIGURE I

DORRIS - BUTTE VALLEY
WATER QUALITY INVESTIGATION

LOCATION MAP

SCALE OF MILES
0 40 80

INTRODUCTION

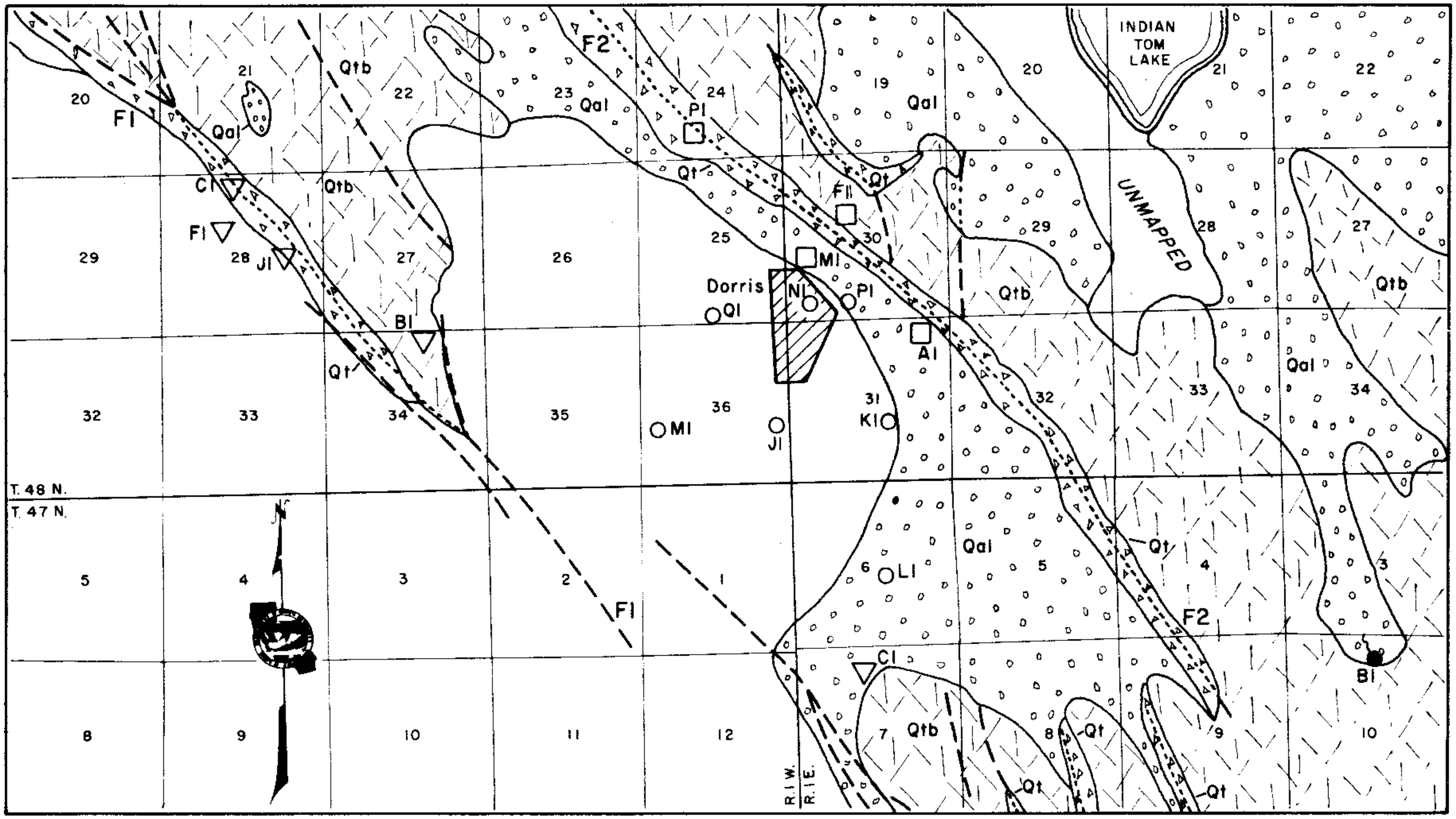
Although Arsenic was known to exist at low levels in Butte Valley ground water, the detection of increases in concentration to levels exceeding drinking water standards motivated this investigation. It consisted of a study of the local geologic and water quality conditions to define the extent of Arsenic impaired ground water and determine possible sources of impairment. The State Department of Public Health was notified and its Bureau of Sanitary Engineering was very helpful during the investigation. Data were collected and evaluated and inquiries concerning industrial processes were made. Recommendations for action are included in this report. The present monitoring program was evaluated and changes made which will provide more complete data on the basin and the quality of its ground water.

Other Investigations and Reports

United States Geological Survey (USGS) Water Supply Paper 1491, "Geology and Ground Water Features of the Butte Valley Region, Siskiyou County, California", by P. R. Wood, is a comprehensive study of the geology of the region and its influence on the ground water regimen. The report supplied valuable background material on the area. The Department's ground water monitoring program provided valuable water quality data and was responsible for initially detecting the problem.

Area of Investigation

The investigation was confined to the northern end of Butte Valley, with specific emphasis directed to the northeastern quarter, the area surrounding Dorris (Figures 1 and 2).



LEGEND

Ql	LAKE DEPOSITS
Qt	TALUS
Qal	ALLUVIUM
Qtb	VOLCANICS OF HIGH CASCADES

SYMBOLS

- FAULTS OR FISSURES
- ▽ WELLS IN BEDROCK ALONG FAULT ZONE F1
- □ WELLS IN BEDROCK ALONG FAULT ZONE F2
- ○ SHALLOW WELLS IN LAKE SEDIMENTS
- SPRINGS

DORRIS - BUTTE VALLEY
WATER QUALITY INVESTIGATION

GEOLOGIC MAP OF
BUTTE VALLEY REGION
SHOWING WELL LOCATIONS

SCALE OF MILES

0 1 2

FIGURE 2

Culture

Farming and stockraising are the two principal agricultural pursuits engaged in the valley. Both dry farming and irrigated agriculture are practiced; however, there is an apparent trend toward irrigation with ground water serving as the source of supply. The population of Dorris is about 1000 and that of Butte Valley 2000.

There is a lumber mill and moulding plant located in Dorris. The lumber mill derives its timber from the mountains west of Butte Valley. The town is located on the Southern Pacific main line between California and Oregon.

The City of Dorris obtains its water from four wells ranging in depth from 130 to 260 feet. The water is pumped into an elevated storage tank and then distributed to the consumers within the city. Well No. 1 (48N/1E/31D1), drilled in 1929, is 150 feet deep; it is used on a standby basis and located near the water tower. Well No. 2 (48N/1E/31E1) was drilled in 1929 and is 130 feet deep. Wells No. 3 (48N/1E/30P1) and 4 (48N/1E/30N1) were drilled in 1947 and 1960 respectively. Well No. 3 is 205 feet deep and well No. 4 is 260 feet deep; both are located on the north edge of town. The water supply system was originally installed in 1910. City officials stated that there were probably several abandoned well installations within the city that may be sources of impairment.

In 1963 a sewage disposal system was installed by the city. Three oxidation ponds were constructed southwest of town in the NW 1/4 of the SE 1/4 of Section 36, T48N/R1W/MDBM. The system was designed for a capacity of 100 gpm. These oxidation ponds were lined with compacted earth. Until recently, when the lining of the pond in use ruptured, only one pond has been in use. An analysis of 75 ppm arsenic was obtained from the pond lining.

Climate

The climate of the valley is semi-arid. Rainfall on the valley floor averages about 15 inches; precipitation in the surrounding mountains ranges up to 40 inches. Summers are warm and dry; winters are cold and wet.

Topography

Butte Valley is an interior basin located on the northern boundary of California in the County of Siskiyou. The elevation of the valley floor is 4250 feet and the surrounding mountains range from 5000 to 8000 feet. The western side of the valley is occupied by a playa lake (Meiss Lake). (A playa is the flat-floored bottom of an undrained desert basin that at times becomes a shallow lake.) Numerous intermittant streams drain onto the valley floor; most of the water from them percolates into the ground water body upon reaching the valley floor. On the west side of the valley several streams meander across the valley and drain into Meiss Lake.

Geology

Butte Valley is on the western edge of the Modoc Plateau. The rocks in the area can be subdivided into two groups, volcanic and sedimentary. The volcanic rocks consist of a series of andesitic to basaltic flows, agglomerates and tuffs of Eocene to Recent age. To the north, east and west, the dominant out-crops are the older volcanic rocks of the "High Cascades". They are highly permeable and serve as an important recharge zone for the ground water body of Butte Valley. To the south the Butte Valley basalt is exposed. It is a gray vesicular basalt, generally permeable. A tongue of the Butte Valley basalt extends into the lake sediments and there may be lenticular remnants of flows interbedded in other areas. The basalt also serves as an important ground water recharge zone.

The principal sediments are semi-consolidated lacustrine deposits which underlie Butte Valley plain. They range in age from Pleistocene to Recent. These deposits consist of interbedded sands, silts, clays and subareal deposits of ash and lapilli. Thin beds of poorly sorted alluvial sand, gravel, and clay have formed along stream channels, in shallow depressions, and around the perimeter of the valley adjacent to the mountains. Small alluvial fans have formed at the mouths of some canyons. Linear wedge-shaped talus strips have developed along fault scarps such as the prominent scarp forming the west side of Mahogany Ridge northeast of Dorris (Figure 2). These talus deposits are very permeable and probably interfinger with lake sediments at depth.

Butte Valley lies in a volcanic region which has been tectonically active in the recent geologic past. Several faults, striking northwest, transect the valley. In the vicinity of Dorris there is evidence that the faults continue in the bedrock under the valley floor. In late June of 1966, an earth shock was felt in Dorris which ruptured the clay lining of the waste effluent evaporative ponds located about one-half mile southwest of town.

GROUND WATER

The surface water falling on or draining onto the valley floor that does not infiltrate into the ground, drains toward Meiss Lake through ditches or stream channels where it eventually is removed from the basin, evaporates, or percolates to the ground water body.

The surrounding hills, because of their highly permeable volcanic nature, are the principal recharge area. Water percolates downward and migrates laterally into the lake basin sediments. In any discussion of the hydraulics and water quality characteristics of the ground water, it is important to remember this: because of the lenticular nature of the numerous pervious and impervious zones, hydraulic continuity does not necessarily exist between aquifers in either a horizontal or vertical direction; horizontal permeability will often greatly exceed vertical permeability. The lenticular nature of the lake sediments is evident from the examination of well logs in the area.

Extensive water level measurements in Butte Valley indicate that the ground water gradient is to the northeast and that there is possible underground flow through Mahogany Ridge northeast of Dorris. The ground water would migrate toward Lower Klamath Lake, which is approximately 200 feet lower in elevation.

The depth of water in the vicinity of Dorris varies between 40 and 50 feet. Two miles to the southwest, ground water levels rise to 20 feet below the surface. In the vicinity of Dorris, several wells have recently been drilled into the volcanics underlying the lake sediments. Water levels in these wells rise to within 30 feet of the surface;

this makes them pressure wells and demonstrates the high isotropic permeability of the volcanics as opposed to the low, variable permeability of the lake sediments.

The evidence of faulting and recent seismic activity indicates that there may be vertical paths of high permeability interconnecting the more pervious water-bearing zones of the lake sediments and the underlying volcanics.

Ground Water Quality

The ground waters in Butte Valley are predominately sodium bicarbonate in character. Both the analyses from the ground water monitoring program and samples collected during this investigation show this characteristic. The stiff diagrams of Figure 3 clearly illustrate this. There is an area west of Dorris where there is no dominant cation, and sodium plus potassium, calcium and magnesium are present in approximately equal amounts (Figure 4).

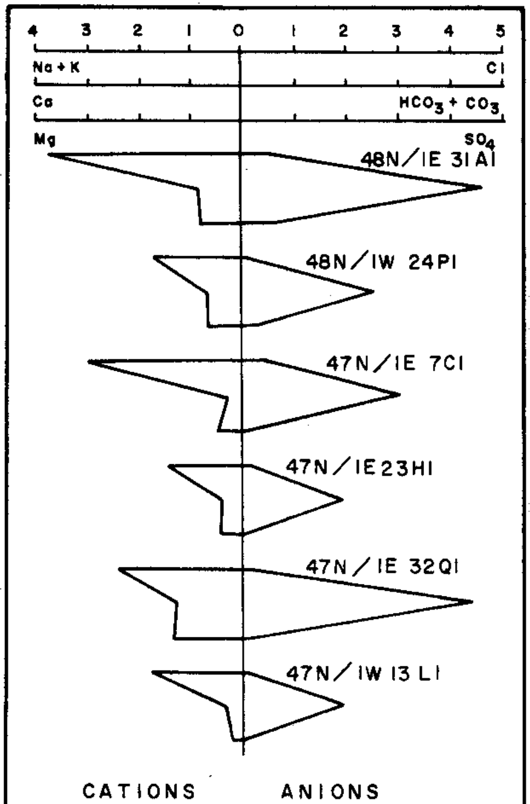


FIG. 3

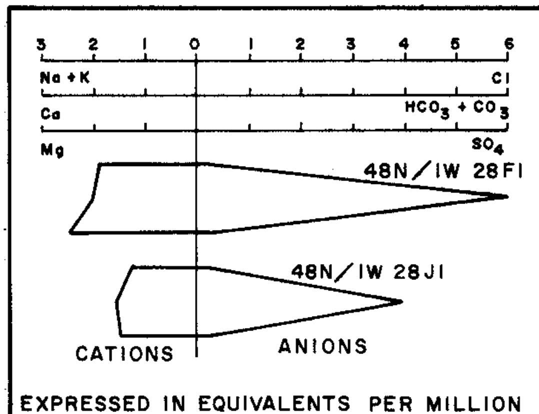


FIG. 4

The range of concentration for several of the chemical constituents and the number of samples represented are shown in Table 1 below:

TABLE 1
(Values in parts per million)

	High	Low	Average	Median	No. Samples
TDS	818	122	319	158	19
Na + K	246	18	77	42	19
$CO_3 + HCO_3$	870	112	306	229	20
As	0.076	0.000	0.017	0.009	27
As*	0.023	0.000	0.008	0.006	22

* Does not include shallow wells in the vicinity of Dorris with high As analyses.

Chapter 7 of the California Health and Safety Code contains the standards relating to domestic water supply. Section 4010.5 of this code refers to the drinking water standards promulgated by the United States Public Health Service for those subject to interstate quarantine regulations. They are set forth in detail in the United States Public Health Publication No. 956 issued August 1962. According to the above-named publication, chemical substances in drinking water supplies, either natural or treated, should conform with the limitations presented in Table 2.

TABLE 2

LIMITING CONCENTRATIONS OF CHEMICAL CONSTITUENTS FOR DRINKING WATER
States Public Health Service Drinking Water Standards 1962

Constituents	PPM
Mandatory	
Arsenic	0.05
Fluoride	0.8 - 1.7*
Lead	0.05
Hexavalent Chromium (Cr^{+6})	0.05
Cyanide	0.2
Selenium	0.01
Barium	1.0
Cadmium	0.01
Silver	0.05

(continued)

TABLE 2 (continued)

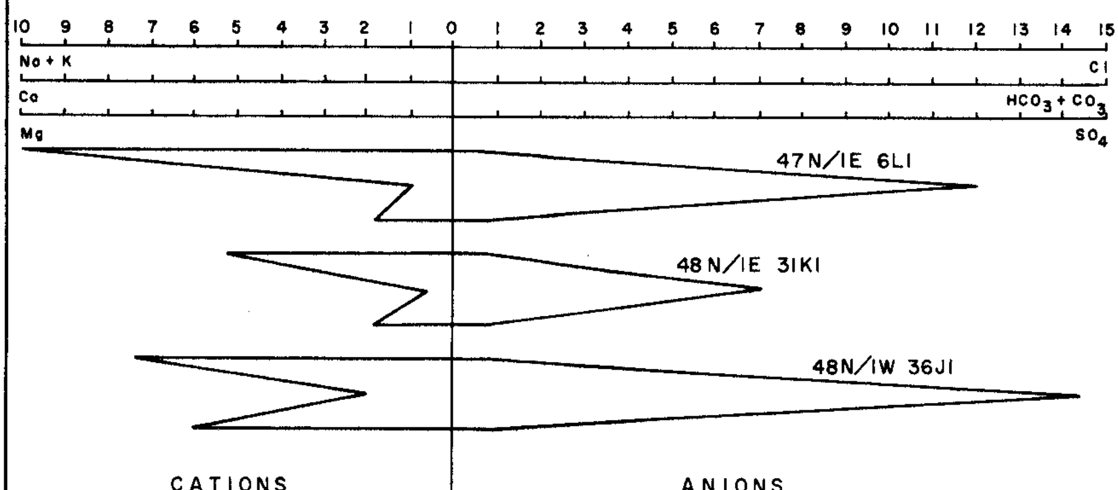
Constituents	PPM
Recommended	
Alkyl Benzene Sulfonate (A.B.S.)	0.5
Arsenic	0.01
Chloride	250.
Copper	1.0
Carbonchloroform Extract (C.C.C.)	0.2
Cyanide	0.01
Fluoride	0.7 - 1.2*
Iron	0.3
Manganese	.05
Nitrate	45.
Phenols	0.001
Sulfate	250.
Total Dissolved Solids	500.
Zinc	5.0

* Varies with temperature

The presence of arsenic in quantities that exceeded those recommended for drinking water prompted this investigation.

The investigation revealed that there were several differences in the quality of the waters in Butte Valley. They depend primarily upon whether the source is the lake sediments or the volcanics. Chemical differences are of degree rather than kind. There was a wide range in temperature differences depending upon the source of water.

Sample data for the Dorris area have been compiled in Table 3 and grouped according to certain geological parameters. The first group represents wells along fault zone FI (Figure 2) which have penetrated the "High Cascades" volcanics either because of their proximity to the hills or because they have been drilled through the lake sediments. The second group are wells in volcanics along fault zone F2 northeast of Dorris or the adjacent fault talus. As noted earlier, with the exception of the wells at the north end of fault zone FI (48N/1W/28) the waters are sodium bicarbonate in character. The important difference is in the temperatures encountered. In over half of the wells the water temperature is in excess of 60°F and ranges up to 76°F. All but five of the wells had water temperatures in excess of those recorded in wells drawing water from lake sediments. The average temperature of water from volcanics was 62°F as opposed to 57°F for water from lake sediments. Three of the wells along fault zone FI also gave off a sulfurous odor. This evidence of higher temperature, sulfurous odor, and faulting indicates the proximity of a geothermal source probably related to volcanic activity.



EXPRESSED IN EQUIVALENTS PER MILLION
FIG. 5

The third group of wells shown in Table 3 are of medium depth (360 and 400 feet) and differ from the other wells shown on the table in Total Dissolved Solids (TDS) present in the water. The TDS levels in these waters range from 468 to 818 ppm and are considerably higher than all the others. These higher values create a considerable difference between the median and average values, as shown on Table 1. Although the depth of 48N/1W/36J1 is not known, its chemical similarity with the other two wells in this group is illustrated in Figure 5 which indicates that it probably penetrates to approximately the same depth.

The high TDS values are probably the result of the wells penetrating buried playa deposits developed during the geologic evolution of Butte Valley, and the evaporites formed have not been redissolved by the ground waters.

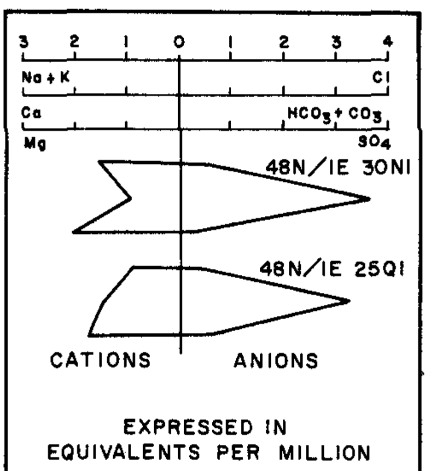


FIG. 6

The last group of wells are the city wells of Dorris and a private well one-half mile west of town (48N/1W/25Q1); these wells range in depth from 130 to 260 feet. The water from this last group of wells and the water from the volcanics is similar. This can be seen by comparing the stiff diagrams of the last group of wells (Figure 6) and the Electrical

Conductivity (E.C.) of their waters with the E.C. of the waters derived from the volcanics. The water is different in one way: water from the last group has a high arsenic content ranging from 0.4 to 0.7 ppm. Included in this group is one surface sample.

The preceding discussion illustrates a point stressed earlier; that is, the lenticular nature of the lake sediments, and the limited vertical mixing between the numerous pervious zones. With the possible exception of near surface aquifers, ground waters in the lake sediments are probably recharged laterally from the adjacent volcanics.

Table 1 shows the extreme, median, and average amounts of arsenic present in the ground water, using two sets of values: the arsenic content of all the wells, including the high arsenic (As) content encountered in shallow wells in the immediate vicinity of Dorris and the arsenic (As) content in all the other wells.

The results of analyses, the water temperatures and sulfurous odor recorded in wells, bedrock penetration, the seismic activity in the area, the volcanic nature of the regional geology, and the sporadic low-level occurrence of arsenic recorded in state-monitored wells in this part of California all indicate a magmatic source of very low-level arsenic (Table 3, Group 1) concentration in the waters derived from the volcanic rocks around Dorris. The average and median of the analyses shown on Table 1 and the bargraph (Figure 7), which shows the number of arsenic determinations grouped by concentration level, indicate an expected model value not in excess of 0.01 ppm with a probable maximum value of 0.02 ppm for the arsenic derived from a magmatic source. It is also pointed out that two of these wells with the highest arsenic values, 48N/1E/32A1 and 48N/1W/24P1, are down gradient from the impaired area, in material of very high permeability. Also, well 48N/1E/32A1 is only 265 feet deep. Their high arsenic values are caused by waters from the shallow ground water body.

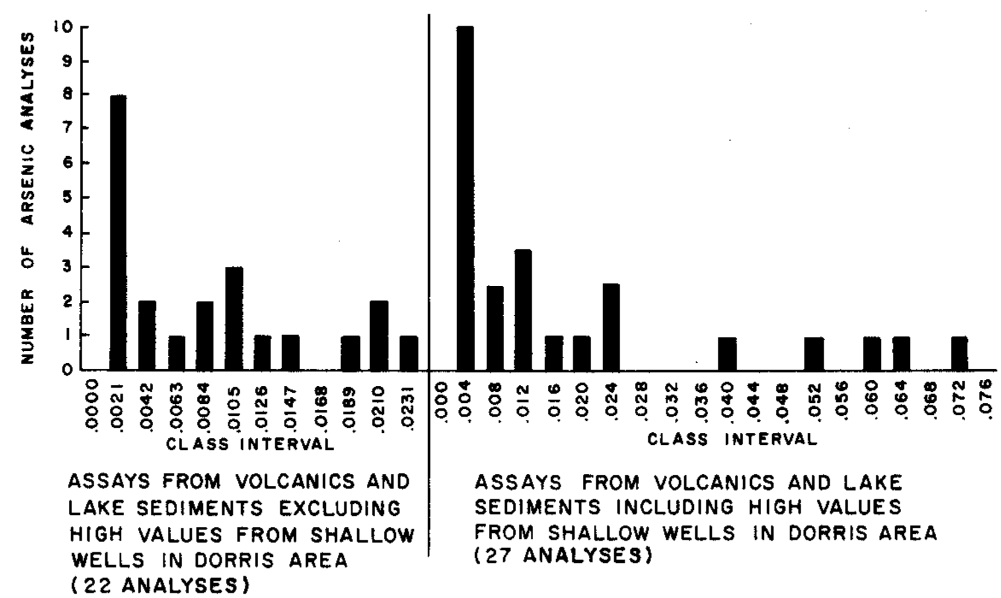


FIG. 7

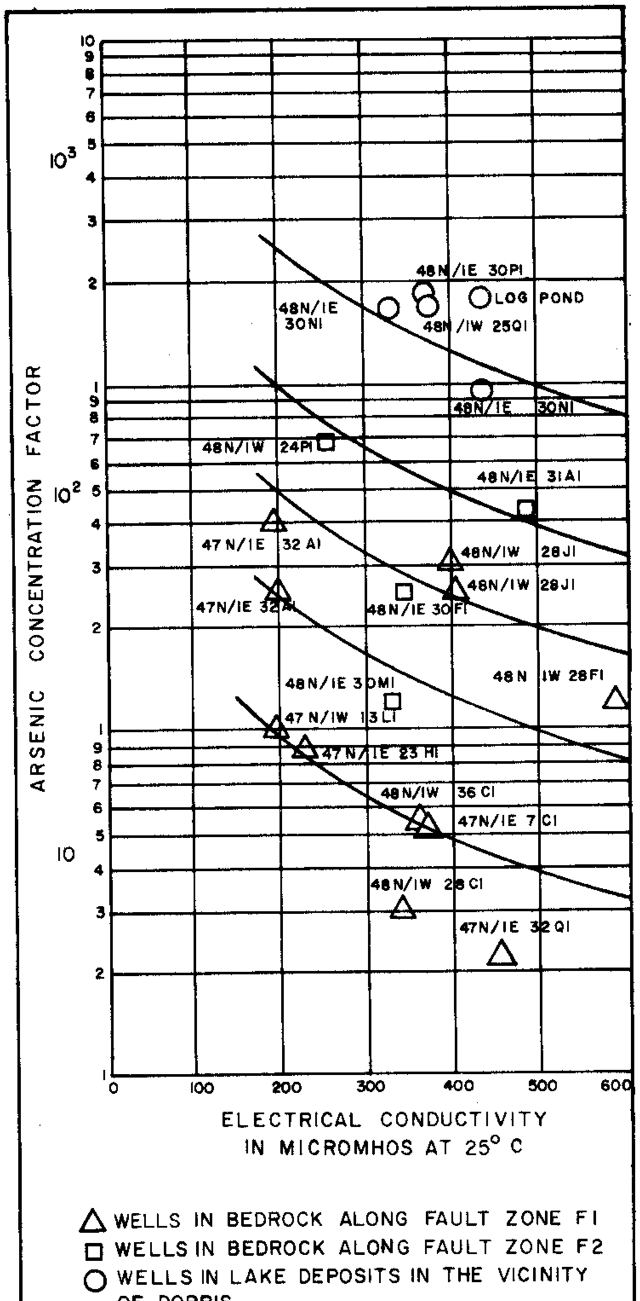


FIG. 8

An attempt was made to correlate arsenic with other chemical and physical parameters, but no clear-cut pattern could be established. Figure 8 is a plot of the Arsenic Concentration Factor (As in ppm divided by E.C.) against E.C. which correlates closely with TDS. It can be seen that the data is scattered. However it might be grouped along lines of equal arsenic concentration (irrespective of the E.C.), but no clear-cut pattern can be established.

Table 3 shows both the Arsenic Concentration Factor and arsenic in ppm. Attention is directed to those wells in Group III -- the average or median value of this group is about twice the average of Groups I and II. This is also the group with the high TDS. Minute quantities of arsenic salts deposited with evaporites have not been redissolved. This is illustrated by the adjacent arsenic concentration factors which are within the range of those in Groups I and II. It is also possible that vertical diffusion has taken place. Earlier analyses from 48N/1W/36J1 tend to support this.

The Arsenic Concentration Factors in the waters of Group IV range from over two to over four times the highest concentration of arsenic in Groups I, II, and III. The bargraph in Figure 7 illustrates the anomalous concentration of arsenic which has taken place in the waters from these wells. The fact that they are from the relatively shallow part of the ground water body, that there is probably no direct magmatic connection, and that the other high arsenic analyses were obtained from surface samples (Table 3), points to a possible surface source of pollution of these waters.

In the past, arsenical compounds have been used by the lumber industry. Although the evidence is not conclusive, industrial operations may have contributed arsenical compounds to the ground water body, further increasing the concentration of arsenic in the Dorris water supply. The analysis of 75 ppm from the waste evaporative pond lining demonstrates that arsenic has been accumulating in the pond lining. This could be caused by accumulation from sewage in the pond since the system has been in use. Prior to the installation of the central sewage system, water from individual disposal systems would have percolated downward, and eventually be repumped by the City well system. Over a period of years the arsenic concentration may have been increased several fold. This is also illustrated by American Forest Products log pond. The water from their well had an arsenic content of 0.023 ppm and an arsenic concentration factor of 18, while the log pond had an arsenic content of 0.076 ppm and an arsenic concentration factor of 178, or ten times that of the water from their well. Evaporation from the log pond would cause this increase in arsenic concentration.

At the saw mill and moulding plant located in Dorris, current practice is to treat certain species of pine with an antifungicidal and antistaining chemical. The chemicals reported used do not contain arsenic. The log pond had one of the highest arsenic analysis obtained, although the company reported the pond to be untreated with chemicals. Arsenical compounds are reported to have been used in the past as an antifungicidal agent in mill operations, but it is not known if they have been used in the Dorris area. Since the company's well contains arsenic, the high analysis from the log pond could be caused by accumulation as explained above.

The Southern Pacific Railroad main line to Oregon passes through Dorris. A visual inspection of the rail facility showed no activity which might contribute to the arsenic pollution. No information relating to past practices of the railroad was obtained.

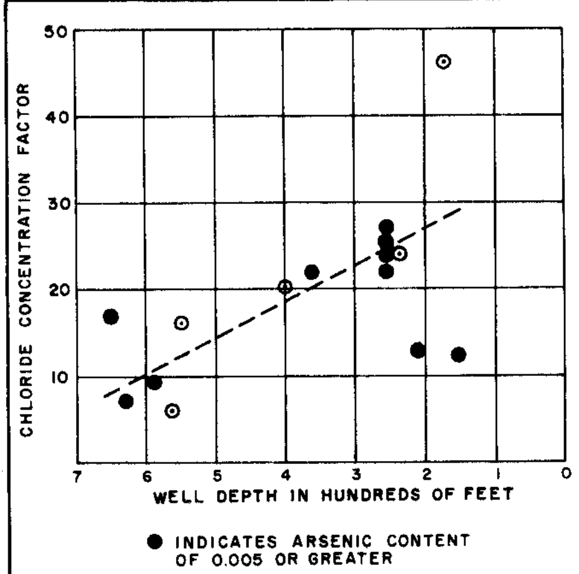


FIG. 9

Figure 9 shows that there is some correlation between chloride concentration factors and well depth. This is a further indication of a surface source of impairment; however, the statistics are limited.

The county agricultural agent was asked about the use of arsenical compounds in agricultural practice in Butte Valley. At present there is no known use of arsenical compounds for control of weeds, rodents, or other pests, although it may have been used in the past. Arsenic has been used in sheep dip, but if still used, it did not appear that practice would be of sufficient magnitude to be responsible for the problem.

FINDINGS AND CONCLUSIONS

1. There is ample evidence indicating low-level arsenic degradation of magmatic origin in the ground waters of Butte Valley. The hydraulic nature of the ground water body accounts for the possibility of encountering these arsenical waters in the lake sediments.

2. Geological observations and geochemical data indicate that the arsenic of magmatic origin has a modal value of about 0.01 ppm.

3. The high arsenic values are from shallow wells.

4. High arsenic values were recorded in surface samples in the immediate vicinity of the City of Dorris.

5. The other geological and geochemical data presented do not support a magmatic origin for these anomalous values.

6. It is concluded that the arsenic impairment in the City of Dorris wells is primarily of surface or near surface origin.

7. There is no indication that arsenic was or is being used by agricultural industry around Dorris.

8. The Southern Pacific line to Oregon passes through Dorris, but a cursory observation indicated no activity which might contribute to the arsenic pollution.

9. The arsenic impairment is probably the result of a combination of several factors. The recirculation of the near surface ground waters in combination with a certain amount of recharge from waters containing low-level arsenic has probably amplified the amount of arsenic in the City of Dorris water supply.

RECOMMENDATIONS

Because the arsenic impairment appears to have come primarily from a surface source and the nature of the chemical indicates an industrial source, it is recommended that the Regional Water Quality Control Board be cognizant of this when establishing waste water discharge requirements, in order to provide maximum protection of the ground water body and make full utilization of its beneficial uses.

The arsenic was probably introduced into this basin in the historical past. Because ground water pollution is slow to develop and slow to clear up, the only remedial action recommended for the affected wells is for the City or Department of Public Health to maintain a continuous monitoring program to assure that the arsenic levels do not reach a point injurious to public health.

The City of Dorris has other problems associated with their water supply. The present wells are not providing an adequate quantity of water, and sand is being pumped into the system. The City is considering developing an alternate source of supply. In the development of any new source, and in light of the data presented above, it is recommended that either the lake sediments be penetrated and water be extracted from the underlying volcanics or a well be located to the north or northeast of the City in or adjacent to the volcanics. A private well (48N/1E/30M1), 415 feet deep, obtains water of desirable quality and low temperature and is approximately 700 feet north of wells 48N/1E/30N1 and 48N/1E/30P1 belonging to the City of Dorris.

The Northern District of the Department of Water Resources will continue to monitor wells extracting water from volcanics in order to detect any change in deleterious substances being contributed to the ground water.

It has also initiated a rotating well monitoring program gradually covering the entire valley. The quality differences discussed previously and shown on Table 3 in the respective groups depend upon location, depth, and the material that the well has penetrated.

In the program inaugurated, the monitored wells would be rotated periodically - e.g., every three years - a statistically valid picture of the geochemical differences in the ground water body, both areally and vertically, would gradually be developed. Geological and geographical considerations within the valley would govern the choosing of the wells to be monitored. It is also possible that with the accumulation of data, a better understanding of the hydrodynamic behaviour of the ground water basin would be achieved.

An example of such a program can be illustrated from the data in this report. Two or three wells could be sampled from the wells in each of the four groups shown in Table 3. Two or three appropriately spaced wells along fault zones F1 and F2 would be sampled for three years. This procedure would also be applied to wells of shallow and medium depth in the lake sediments. After a period of three years, other wells in the valley could be substituted, based on similar geologic considerations. Wells should be selected where well logs are available or depth and perforations are known. Periodically wells should be back checked to determine if any significant changes have taken place with time.

TABLE 3

MINERAL ANALYSES OF GROUND WATER

DORRIS – BUTTE VALLEY WATER QUALITY INVESTIGATION

Owner and use	State well number and other number	Date sampled & Well Depth	Temp in °F	Specific conductance (micromhos at 25° C)	pH	Mineral constituents in parts per million / concentration factor* Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Arsenic (As)	Remarks	Total[a] dissolved solids in ppm	Per-cent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Analyzed by[b]
Group I - Wells Penetrating Bedrock Along Fault Zone F1																							
Ken Holbrook, Irrig.	47N/1E-32A1	5-25-66 265'	69	200	8.1	7.1	3.5	29	7.8	0	115	1.5	5.1 / 25	1.2 / 6		0.000 / 0	0.009 / 25	Penetrates Volcanics	132				
Russell Britches, Irrig.	47N/1E-32Q1	4-27-66 135'	56	459	8.1	24	15	49	8.6	0	261	9.4	11 / 24	2.2 / 4.8		0.072 / 158	0.001 / 2.2	Penetrates Volcanics	287				
Ken Holbrook, Irrig.	47N/1E-32A1	6-22-64 265'	67	198	8.2	5.0	4.2	28	7.6	0	115	0.0	4.7 / 24	1.0 / 5		0.034 / 172	0.008 / 40	Penetrates Volcanics	155				
Mike DeRuesi, Irrig.	47N/1W-13L1	4-27-66 1100+	52	198	8.1	5.4	2.8	33	8.8	0	116	0.0	4.6 / 23	1.9 / 9.6		0.103 / 520	0.002 / 10	Penetrates Volcanics	122				
W. W. Cowin, Domestic	47N/1E-23H1	9-12-63	-	227	7.6	7.9	4.7	28	7.4	0	112	1.2	7.8 / 34	5.3 / 23		0.046 / 202	0.002 / 8.8	Penetrates Volcanics	154				
John Lisky, Irrig.	48N/1W-28C1	4-28-66 560'	59	338	7.9	27	21	11	6.5	0	213	3.1	2.2 / 6.5	2.1 / 6.2		0.041 / 121	0.001 / 3.0	Penetrates Volcanics	190				
Joe Liptak, Irrig.	48N/1W-36M1	8-11-66 1100'	--	361	--	--	--	--	---	-	---	---	--	--			0.002 / 5.5	Penetrates Volcanics	---				
Russell Smith, Irrig.	47N/1E-7C1	4-27-66	76	370	8.0	4.6	4.5	61	15	0	188	1.8	17 / 46	0.8 / 2.2		0.185 / 500	0.002 / 5.4	Also penetrates volcanics SO_2 smell	239				
Roy Price, Irrig.	48N/1W-28J1	5-24-66	61	402	8.3	33	17	24	8	0	236	12	4.5 / 11	1.1 / 2.7		0.000 / 0	0.012 / 30	Penetrates Volcanics	216				
Roy Price, Irrig.	48N/1W-28J1	6-22-64	57	404	8.0	31	19	24	7.8	0	240	9	4.8 / 12	1.7 / 4.2		0.028 / 69	0.010 / 25	Penetrates Volcanics	258				
John Liskey, Irrig.	48N/1W-28F1	4-28-66 632'	53	589	8.2	42	30	41	7.8	0	363	10	4.6 / 7.8	9.4 / 16		0.120 / 204	0.007 / 12	Penetrates Volcanics SO_2 Smell	348				
Orr Storey,	48N/1W-34B1	4-28-66	68	458	8.3	20	14	51	16	0	274	4.3	7.2 / 16	0.8 / 1.7		0.1838 / 410	0.00 / 0	Penetrates Volcanics SO_2 Smell	258				
Group II - Wells Penetrating Bedrock Along Fault Zone F2																							
George Alderson, Irrg.	48N/1W-24P1	5-25-66 585'	73	262	8.5	12	7.3	33	6.8	5.9	145	7.9	2.6 / 9.9	0.0 / 0		0.000 / 0	0.018 / 69	Penetrates Volcanics	166				
John Liskey, Irrig.	48N/1E-30M2	8-11-66 415'	--	329													0.004 / 12	Penetrates Volcanics					
John Liskey, Irrig.	48N/1E-30F1	6-22-64	54	343	8.2			22		0	204		2.7 / 7.9				0.009 / 26	Penetrates Volcanics					

* Lower figure is concentration factor (Ions in ppm / Electrical Conductivity)

TABLE 3 (CONT.)

MINERAL ANALYSES OF GROUND WATER

DORRIS – BUTTE VALLEY WATER QUALITY INVESTIGATION

Owner and use	State well number and other number	Date sampled & Well Depth	Temp in °F	Specific conductance (micromhos at 25° C)	pH	Mineral constituents in parts per million / concentration factor * Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Arsenic (As)	Remarks	Total[a] dissolved solids in ppm	Per cent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Analyzed by [b]
						Group II - Wells Penetrating Bedrock Along Fault Zone F2 (Continued)																	
John Lisky Irrig.	46N/1E-31A1	5-25-66 201'	69	485	8.6	14	8.5	84	31	11	247	27	6.5 / 13	1.1 / 2.3		0.249 / 513	0.021 / 43	Penetrates Volcanics	262				
City of Dorris	48N/1E-30D1	8-12-66 650'	61.6	450									7.6 / 17				0.006 / 13	Penetrates Volcanics					
						Group III - Wells of Medium Depth in Lake Sediments																	
Wm. Harp, Irrig.	48N/1E-31K1	4-28-66 360'	57	734	8.4	10	23	112	22	6	409	25	16 / 22	1.5 / 2.0		0.274 / 374	0.013 / 28		468				
Russell Smith, Irrig.	47N/1E-6L1	4-27-66 400'	57	1140	8.2	21	22	220	23	0	732	7.2	23 / 20	2.6 / 2.3		1.504 / 1320	0.004 / 3.5		714				
American Forest Prods	48N/1W-36J1	5-25-66	55	1330	8.4	43	73	154	30	12	858	23	23 / 17	4.8 / 3.6		0.117 / 88	0.021 / 16		787				
	48N/1W-36J1	6-22-64	54	1300	7.3	37	68	160	30	0	843	27	25 / 19	7.3 / 5.6		0.021 / 16	0.023 / 18		818				
						Group IV - Shallow wells in Lake Sediments near Dorris and Surface Samples																	
City of Dorris #3	48N/1E-30P1	3-17-66]	58	364													0.066 / 181						
City of Dorris #4	48N/1E-30N1	3-17-66 260'	54	325													0.053 / 163						
City of Dorris #4	48N/1E-30N1	6-22-64	-	437	8.1	18	26	28	12	0	221	21	12 / 27	6.7 / 15		0.060 / 138	0.042 / 96		271				
T. S. Cavener	48N/1W-25Q1	5-25-66 147'	55	368	8.4	28	19	17	5.9	5.0	188	23	4.2 / 12	6.7 / 15		0.000 / 0	0.061 / 166		210				
American Forest Prod.	48N/1W-36 Log Pond	8-11-66		426													0.076 / 178						
Sewage Pond			55.7														75.00						
City of Dorris #3	48N/1E-30P1	5-25-66 205'		396	8.6	21	17	37	9.4	8	218	8.2	5.0 / 13	1.3 / 3.3		0.1 / 25	0.009 / 23		240		0	122	
City of Dorris #4	48N/1E-30N1	5-25-66 260'		362	8.5	16	22	21	8.2	7	163	2.1	8.6 / 24	4.4 / 12		0.0 / 0.0	0.067 / 185		210		0	130	

* *Lower figure is concentration factor (Ions in ppm / Electrical Conductivity)*